

Refraction of 1-year-old children after cycloplegia with 1% cyclopentolate: comparison with findings after atropinisation

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SUMMARY Cyclopentolate 1% is significantly less effective than atropine 1% at producing cycloplegia in 1-year-old children. If cycloplegic refraction is to be used for investigation or screening children for visual defects *during the sensitive period*, the more prolonged and profound cycloplegia following atropine could potentially have a disastrous effect on the development of vision. Cyclopentolate 1% would have to be used, and allowance made for its inadequacy as a cycloplegic.

The feasibility study of screening 1-year-old children (Ingram *et al.*, 1979) was followed up and extended into adjacent parts of this district using atropine 1% and cyclopentolate 1% for cycloplegia. If retinoscopy after cycloplegia is to be used for further investigation of the possibility of preventing amblyopia and squint, and if it is ever to become a recognised method of screening large numbers of infants for visual defects, the choice of cycloplegic drug might be important. The advantages and disadvantages of atropine and cyclopentolate, the 2 drugs that are probably most commonly used, need to be compared, particularly with regard to (1) their efficiency as a cycloplegic; (2) their side effects and safety; (3) whether the mothers had a preference for one or the other, because it is no good having an efficient screening test if the public cannot be persuaded to use it.

Samples of children

Children born between January 1975 and December 1976 and registered on their first birthday with 3 group practices in the town of Rushden were used in this investigation. Those born in 1975 had cyclopentolate 1% instilled once, 30 minutes before retinoscopy. Those born in 1976 had cyclopentolate 1% instilled twice, 40 and 30 minutes before retinoscopy. The mothers instilled the cyclopentolate drops, as it was thought it would be more convenient for them and the clinical staff.

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The findings have been compared with those refracted after atropine cycloplegia (Ingram, 1979) and with the sample of children reported in the pilot study (Ingram *et al.*, 1979).

Methods

The organisation of the screening was the same as that described for the children refracted after atropine cycloplegia (Ingram, 1979). All the refractions were performed by the same person (R. M. I.).

The refractions of the various groups were then compared to see if (1) The basic spherical refractions of one group were more hypermetropic than another. That is, was the mean spherical refraction different when one group was compared with another? (2) The range of the basic spherical refractions of individual eyes or children was different in one group to that of another. That is, did the spread of the curve differ between individual groups? (3) The incidence of astigmatism and/or anisometropia differed.

Results

There is no significant difference between the mean or the spread of the distribution curves for any of these 3 samples of children when either the basic spherical refraction of individual eyes (Table 2) or the basic spherical refraction of the more emmetropic eye was recorded (Table 3).

There is no significant difference in the incidence of any of these refractions between children born in 1975 and 1976 (Table 4).

Table 1 Particulars of the samples of children screened after cyclopentolate 1%

	Born 1975	Born 1976
Total number available for screening	355	415
Number who 'declined' examination	4	3
Did not attend	52	83
Refraction impossible	6	6
Others—squint, congenital abnormalities, etc.	2	0
Number who were refracted	291 (82%)	323 (78%)

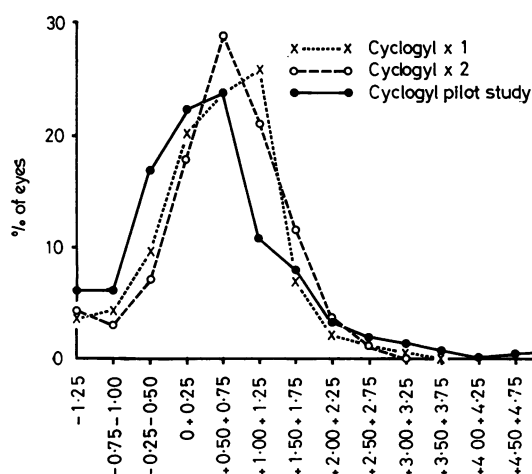


Fig. 1 Distribution curves representing the basic spherical refractions of individual eyes examined after cyclopentolate 1%

Comparison of either of the 1975 and 1976 cyclopentolate samples with any one of the 1974, 1975, and 1976 atropine samples shows that the mean of the cyclopentolate samples is significantly less hypermetropic than that of any of the atropine samples. In all cases, when either the basic spherical refraction of individual eyes or of the more emmetropic eye of a child is recorded, the difference is significant at the 1% level.

Moreover, the incidence of bilateral spherical hypermetropia of +2.00 or more D is significantly higher after cycloplegia with atropine than it is after the use of cyclopentolate (Table 5).

The means of the cyclopentolate 1975 and 1976 samples are significantly different for the horizontal meridian at the 5% level but not for the vertical meridian. The spreads of the distribution curves for these samples are not significantly different in either meridian. In both the cyclopentolate samples the

means of the horizontal meridian are significantly different from the means of the vertical meridian at the 1% level. There is no such difference in the atropine samples. It is not known whether this is due to the cycloplegic drug or to different population samples. There is no significant difference between the means or the spreads of the distribution curves of any of the atropine 1974, 1975, and 1976 samples in either meridian. The means of both the cyclopentolate samples differ significantly at 1% level from the means of each of the atropine samples in both meridians. The spreads of the distribution curves of both cyclopentolate samples differ significantly, at the 5% level or less, from the spreads of the distribution curves of all the atropine samples in both meridians.

Table 2 Basic spherical refractions of individual eyes and children

	Mean	SD	SE
Born 1975	0.59	0.88	0.04
Born 1976	0.58	1.05	0.05
Pilot study	0.64	0.82	0.03

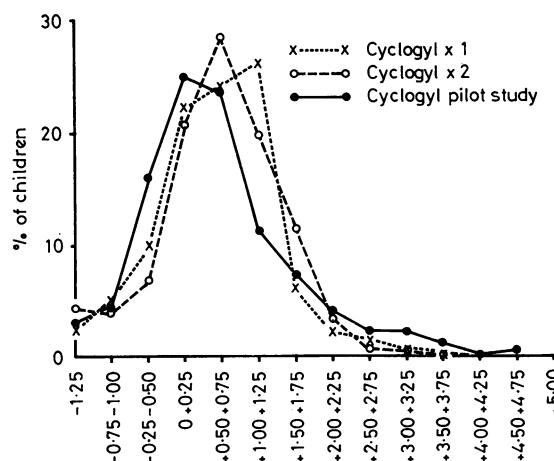


Fig. 2 Distribution curve representing the basic spherical refractions of the more emmetropic eye of children examined after cyclopentolate 1%

Table 3

	Mean	SD	SE
Born 1975	0.55	0.81	0.05
Born 1976	0.59	0.80	0.04
Pilot study	0.55	1.00	0.07

Table 4 *Incidence of spherical hypermetropia, astigmatism, and anisometropia after refraction following cyclopentolate 1%*

	Born 1975	Born 1976
Number of children with bilateral spherical hypermetropia of +2.00 or more DS	11	14
Incidence of bilateral spherical hypermetropia	3.78%	4.33%
Number of individual eyes with +1.50 or more D astigmatism	75	93
Incidence of astigmatism +1.50 or more D in individual eyes	12.88%	14.40%
Number of children who had +1.50 or more D astigmatism in either or both eyes	47	60
Incidence of astigmatism of +1.50 or more D in either or both eyes	16.15%	18.57%
Number of children who had anisometropia	17	17
Incidence of anisometropia	5.84%	5.26%
Incidence of bilateral hypermetropia and/or anisometropia	27/291 = 9.28%	30/323 = 9.28%
Incidence of bilateral hypermetropia and/or astigmatism	57/291 = 19.59%	71/323 = 21.99%

Table 5 *Comparison of the basic spherical refractions after cyclopentolate and atropine cycloplegia*

	1974-76 Atropine	1975-76 Cyclopentolate	Total
< +2.00 DS in both eyes	1453	589	2042
+2.00 or more DS in both eyes	195	25	220
Total	1648	614	2262

P < 0.001

There was a lower incidence of anisometropia detected after cyclopentolate than after atropine, but this difference was not significant. However, an anisometric eye more often than not has +1.50 or more D astigmatism, and if the ratio of anisometric eyes with and without this astigmatism is examined there is a marked difference between the 1976 cyclopentolate sample and the others, which cannot be explained.

There was a higher incidence of astigmatism in the samples refracted after cyclopentolate, which is significantly different when the 1976 sample is compared with the sum of the atropine samples.

Discussion

While this is not an ideal method of comparing 2 drugs, there was no other practical alternative.

Moreover, there was no means of knowing whether either cycloplegic was instilled strictly according to instructions. A mobile pupil obviously suggests incomplete cycloplegia, but a fixed mydriasis is not necessarily an indication of the amount of cycloplegia. Cyclopentolate seems to give variable mydriasis in young children, and this has been reported especially in premature infants (Carpel and Kalina, 1973). On occasions repeated instillations of cyclopentolate by one of us personally (R. M. I.) has failed to increase mydriasis, and even atropine does not invariably produce full mydriasis, particularly in coloured races.

CYCLOPLEGIA AFTER CYCLOPENTOLATE AND ATROPINE

Observations on the children refracted after cyclo-

Table 6 *Refractions in the horizontal and vertical meridia of individual eyes*

Sample	Horizontal meridian		Vertical meridian	
	Mean	SD	Mean	SD
Atropine 1974	+1.21	1.07	+1.16	1.07
Atropine 1975	+1.27	1.11	+1.19	1.11
Atropine 1976	+1.28	1.02	+1.23	1.07
Cyclopentolate 1975	+0.96	0.90	+0.78	0.91
Cyclopentolate 1976	+1.06	0.91	+0.82	0.94

Table 7 *Anisometropia and astigmatism*

	Atropine			Cyclopentolate	
	1974	1975	1976	1975	1976
<1.50 D astigmatism	17	14	10	6	1
1.50 or more D astigmatism	28	23	15	11	16
Ratio	1.65:1	1.64:1	1.50:1	1.83:1	16:1

Table 8 *Comparison of the incidence of astigmatism +1.50 D or more*

	Level of significance, %
1975 Cyclopentolate versus 1974-76 atropine: incidence in individual eyes	6.81
incidence in either or both eyes of a child	8.46
1976 Cyclopentolate versus 1974-76 atropine: incidence in individual eyes	0.26
incidence in either or both eyes of a child	1.48

pentolate cycloplegia show a lower amount of hypermetropia than is the case after atropinisation. This could have been in some way connected with the apparently higher incidence of astigmatism found after cyclopentolate cycloplegia, so the refractions found in the horizontal and vertical meridians were compared, but again there was a significantly (at 1% level) lower amount of hypermetropia in both meridians when cyclopentolate was used. The consistently lower amount of hypermetropia recorded after the use of cyclopentolate than after atropine (approximately 0.40 D) is well illustrated by the significantly lower incidence of bilateral hypermetropia, and it is clear that the cycloplegic effect of 1% cyclopentolate is not as profound as that of atropine 1%. On the other hand it does not seem to matter whether mothers or nurses instilled the cyclopentolate, or whether the drops were instilled once or twice (Figs. 1 and 2).

In the past cyclopentolate has been compared (for mydriasis and cycloplegia) with homatropine (various percentages) plus or minus ephedrine (Abraham, 1953; Stolzar, 1953; Milder and Riffenburgh, 1953; Ehrlich, 1953; Gettes, 1954; Gordon and Ehrenburg, 1954; Mitchell *et al.*, 1958) but so far as we are aware only once with atropine. Cowan and Archer (1962), reporting on 20 'representative cases', found that if the pupils were not actively mobile cyclopentolate was as effective a cycloplegic as atropine. However, their cases were all children attending for squint and amblyopia and were not necessarily representative of the whole.

It is not known why there was a higher incidence of astigmatism found in the children refracted after cyclopentolate. This has been considered from various angles, and, although it is possible that cyclopentolate in some way 'reveals' more astigmatism, it is quite likely that the incidence of astigmatism (or other abnormal refractions) may vary in different population samples.

SAFETY

If it were to be established that hypermetropia in one or more meridians (over and above the ability of that eye to accommodate) during the sensitive period was the basic cause of amblyopia and squint, it is obvious that prolonged cycloplegia (as after the use of atropine) during this period would very likely potentiate stimulus deprivation and itself contribute towards amblyopia. Indeed, this is exactly what the recent experiments of Ikeda and Tremain (1978) suggest will happen. In our experience atropine used at the age of 1 year has not led to amblyopia, but in the first 3 months of life atropine may well be absolutely contraindicated.

It is proposed to continue investigations in

children at the age of 6 months (and in even younger children at a later date) using cyclopentolate 1% in spite of doubts about its efficacy as a cycloplegic. The answer to the problem of identifying those children who would present with squint and amblyopia untreated is unlikely to be pure black-and-white with a clear-cut dividing line. Ultimately the important point will be whether a child who has a refraction of more than a given number of dioptres will have a significant chance of being cured by preventive treatment. The number of dioptres would be relevant to a particular, named, cycloplegic drug, and might be a lower figure if cyclopentolate were used rather than if atropine.

SIDE EFFECTS OF CYCLOPENTOLATE AND ATROPINE

Photophobia resulting from the prolonged mydriasis after atropine was the side effect most commonly remarked on by parents. This worries them because many think that bright light is bad for the eyes, particularly during the summer months, when it might deter them from having their children's eyes screened. This photophobia did not cause concern after cyclopentolate. The absence of prolonged photophobia and the convenience of 2, as opposed to 8, instillations of cycloplegic probably accounted for the higher attendance rate for screening after cyclopentolate. There were no allergic reactions to either drug.

No signs of systemic side effects were found after either drug was used in these children. However, there are isolated reports of systemic toxicity after using Cyclogyl 1% (Simcoe, 1962; Bauer *et al.*, 1973) and after using Cyclogyl 2% (Beswick, 1962; Binkhurst *et al.*, 1963; Praeger and Miller, 1964). All these psychotic reactions were what one would anticipate in view of the parasympatholytic action of the drug, and with the exception of those in a child reported by Bauer *et al.* (1973) all were transient, lasting only a few hours.

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